REMARKS:

The specification has been objected to as failing to provide proper antecedent basis for the claimed term "electrical interface configuration information". Applicant has amended the written description without adding new matter. It is clear throughout the specification and with specific reference to figure 6 that the interface 30 is a configurable electrical interface. Applicant has amended the specification to refer to the interface as an electrical interface. In fact this exact language is used in paragraph 29 to refer to interface 30. Applicant has also amended this paragraph to refer to the configuration information as electrical interface configuration information to satisfy the rejection. Clearly, configuration information for configuring an electrical interface is appropriately referred to as electrical interface configuration information.

Figures 5 and 6 fully support the configurability both of the data translator and the electrical interface. As can be seen in figure 5 for example three different electrical port configurations are shown namely RS232, RS 422, and RS485. These are well known, electrically different, port configurations. Figures 5 and 6 together show that the configurable electrical interface 30 is configured using electrical interface configuration information, to assume one of these three port configurations. Applicant encloses specifications for the RS232, RS422, and RS485 interfaces clearly showing the differences and therefore the changes that must be made to configurable electrical interface 30 to accommodate these three protocols. All of this is entirely consistent with applicant's arguments to date.

Applicant does specifically set forth on page 10, paragraph 32 the elements of an exemplary personality file. The first five of these are electrical interface configuration elements. The last five are data translator elements and user interface screen elements.

The examiner has taken the position that the electrical interface configuration information is not enabled. Applicant respectfully disagrees. Applicant has explicitly shown a configurable electrical interface 30 and has given three examples of configurations conforming to well known standards RS232, RS 422, and RS485. These standards are so well known that one skilled in the art would be able, not only without undue experimentation, but without any experimentation, to configure the electrical interface 30 to a selected one of these standards. The invention is not in the implementation of the configurable electrical interface, which is well within the capabilities of one of ordinary skill in the art, but the idea to provide a combined personality file that includes data translator information and electrical interface configuration information in a single file. The attached information quite clearly shows the single levels and pin outs for the three interface standards. In an extraordinarily simple implementation, all that would be required is to connect three drivers in parallel and select the desired one. Other arrangements will suggest themselves to one of ordinary skill in the art.

Accordingly, the examiner's position that electrical interface configuration is information relating to data translation and protocol interpretation only is clearly inconsistent with the written description of the invention. The electrical configuration information unambiguously relates to the electrical configuration of the configurable interface 30, not to data translation.

Applicant has amended Claim 14 to change "data translation" to "data translation configuration information" as suggested.

The remainder of the rejection repeats the previous rejection. Applicant believes that the forgoing changes and explanations fully support the arguments previously made which were deprecated by the examiner because of the issues concerning electrical configuration information. Now that the nature of the electrical configuration information has been clarified, reconsideration and favorable action are requested.

Respectfully submitted,

Dated: December 13, 2005

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RS232 Data Interface

a Tutorial on Data Interface and cables

RS-232 is simple, universal, well understood and supported but it has some serious shortcomings as a data interface. The standards to 256kbps or less and line lengths of 15M (50 ft) or less but today we see high speed ports on our home PC running very high speeds and with high quality cable maxim distance has increased greatly. The rule of thumb for the length a data cable depends on speed of the data, quality of the cable.

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a Tutorial

Electronic data communications between elements will generally fall into two broad categories: single-ended and differential. RS232 (single-ended) was introduced in 1962, and despite rumors for its early demise, has remained widely used through the industry.

Independent channels are established for two-way (full-duplex) communications. The RS232 signals are represented by voltage levels with respect to a system common (power / logic ground). The "idle" state (MARK) has the signal level negative with respect to common, and the "active" state (SPACE) has the signal level positive with respect to common. RS232 has numerous handshaking lines (primarily used with modems), and also specifies a communications protocol.

The RS-232 interface presupposes a common ground between the DTE and DCE. This is a reasonable assumption when a short cable connects the DTE to the DCE, but with longer lines and connections between devices that may be on different electrical busses with different grounds, this may not be true.

RS232 data is bi-polar.... +3 TO +12 volts indicates an "ON or 0-state (SPACE) condition" while A -3 to -12 volts indicates an "OFF" 1-state (MARK) condition.... Modern computer equipment ignores the negative level and accepts a zero voltage level as the "OFF" state. In fact, the "ON" state may be achieved with lesser positive potential. This means circuits powered by 5 VDC are capable of driving RS232 circuits directly, however, the overall range that the RS232 signal may be transmitted/received may be dramatically reduced.

The output signal level usually swings between +12V and -12V. The "dead area" between +3v and -3v is designed to absorb line noise. In the various RS-232-like definitions this dead area may vary. For instance, the definition for V.10 has a dead area from +0.3v to -0.3v. Many receivers designed for RS-232 are sensitive to differentials of 1v or less.

This can cause problems when using pin powered widgets - line drivers, converters, modems etc. These type of units need enough voltage & current to power them self's up. Typical URART (the RS-232 I/O chip) allows up to 50ma per output pin - so if the device needs 70ma to run we would need to use at least 2 pins for power. Some devices are very efficient and only require one pin (some times the Transmit or DTR pin) to be high - in the "SPACE" state while idle.

An RS-232 port can supply only limited power to another device. The number of output lines, the type of interface driver IC, and the state of the output lines are important considerations.

The types of driver ICs used in serial ports can be divided into three general categories:

- Drivers which require plus (+) and minus (-) voltage power supplies such as the 1488 series of interface integrated circuits. (Most desktop and tower PCs use this type of driver.)
- Low power drivers which require one +5 volt power supply. This type of driver has an internal charge pump for voltage conversion. (Many industrial microprocessor controls use this type of driver.)
- Low voltage (3.3 v) and low power drivers which meet the EIA-562 Standard. (Used on notebooks and laptops.)

Data is transmitted and received on pins 2 and 3 respectively. Data Set Ready (DSR) is an indication from the Data Set (i.e., the modem or DSU/CSU) that it is on. Similarly, DTR indicates to the Data Set that the DTE is on. Data Carrier Detect (DCD) indicates that a good carrier is being received from the remote modem.

Pins 4 RTS (Request To Send - from the transmitting computer) and 5 CTS (Clear To Send - from the Data set) are used to control. In most Asynchronous situations, RTS and CTS are constantly on throughout the communication session. However where the DTE is connected to a multipoint line, RTS is used to turn carrier on the modem on and off. On a multipoint line, it's imperative that only one station is transmitting at a time (because they share the return phone pair). When a station wants to transmit, it raises RTS. The modem turns on carrier, typically waits a few milliseconds for carrier to stabilize, and

then raises CTS. The DTE transmits when it sees CTS up. When the station has finished its transmission, it drops RTS and the modem drops CTS and carrier together.

Clock signals (pins 15, 17, & 24) are only used for synchronous communications. The modem or DSU extracts the clock from the data stream and provides a steady clock signal to the DTE. Note that the transmit and receive clock signals do not have to be the same, or even at the same baud rate.

Note: Transmit and receive leads (2 or 3) can be reversed depending on the use of the equipment - DCE Data Communications Equipment or a DTE Data Terminal Equipment.

Glossary of Abbreviations etc.

CTS	**Clear To Send [DCE --> DTE]**
DCD	**Data Carrier Detected (Tone from a modem) [DCE --> DTE]**
DCE	**Data Communications Equipment eg. modem**
DSR	**Data Set Ready [DCE --> DTE]**
DSRS	**Data Signal Rate Selector [DCE --> DTE] (Not commonly used)**
DTE	**Data Terminal Equipment eg. computer, printer**
DTR	**Data Terminal Ready [DTE --> DCE]**
FG	**Frame Ground (screen or chassis)**
NC	**No Connection**
RCk	**Receiver (external) Clock input**
RI	**Ring Indicator (ringing tone detected)**
RTS	**Ready To Send [DTE --> DCE]**
RxD	**Received Data [DCE --> DTE]**
SG	**Signal Ground**
SCTS	**Secondary Clear To Send [DCE --> DTE]**
SDCD	**Secondary Data Carrier Detected (Tone from a modem) [DCE --> DTE]**
SRTS	**Secondary Ready To Send [DTE --> DCE]**
SRxD	**Secondary Received Data [DCE --> DTE]**
STxD	**Secondary Transmitted Data [DTE --> DTE]**
TxD	**Transmitted Data [DTE --> DTE]**

Is Your Interface a DTE or a DCE?

One of the stickiest areas of confusion in datacom is over the terms "transmit" and "receive" as they pertain to DTE (data terminal equipment) and DCE (data communication equipment). In synchronous communication, this confusion is particularly acute, because more signals are involved. So why is it that you sometimes send data on TD, and other times you send data on RD? Is this just a cruel form of mental torture? Not really. The secret lies in adopting the proper perspective. In data-com, the proper perspective is always from the point of view of the DTE. When you sit at a PC, terminal or workstation (DTE) and transmit data to somewhere far away, you naturally do so on the TD (transmit data) line. When your modem or CSU/DSU (DCE) receives this incoming data, it receives the data on the TD line as well. Why? Because the only perspective that counts in data-com is the perspective of the DTE. It does not matter that the DCE thinks it is receiving data; the line is still called "TD". Conversely, when the modem or CSU/DSU receives data from the outside world and sends it to the DTE, it sends it on the RD line. Why? Because from the perspective of the DTE, the data is being received! So when wondering, "Is this line TD or RD? Is it TC or RC?" Ask yourself, "What would the DTE say?"

Find out by following these steps: The point of reference for all signals is the terminal (or PC).

1) Measure the DC voltages between (DB25) pins 2 & 7 and between pins 3 & 7. Be sure the black lead is connected to pin 7 (Signal Ground) and the red lead to whichever pin you are measuring.

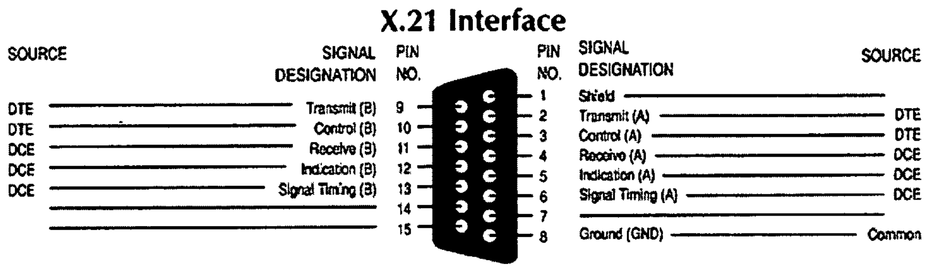
2) If the voltage on pin 2 is more negative than -3 Volts, then it is a DTE, otherwise it should be near zero volts.

3) If the voltage on pin 3 is more negative than -3 Volts, then it is a DCE.

4) If both pins 2 & 3 have a voltage of at least 3 volts, then either you are measuring incorrectly, or your device is not a standard EIA-232 device. Call technical support.

5) In general, a DTE provides a voltage on TD, RTS, & DTR, whereas a DCE provides voltage on RD, CTS, DSR, & CD.

X.21 interface on a DB 15 connector



also see X.21 write up
also see end of page for more info

X.21

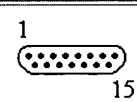
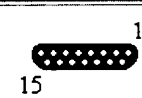
General

Voltages:	+/- 0.3Vdc	
Speeds:	Max. 100Kbps (X.26)	
	Max. 10Mbps (X.27)	

The X.21 interface was recommended by the CCITT in 1976. It is defined as a digital signaling interface between customers (DTE) equipment and carrier's equipment (DCE). And thus primarily used for telecom equipment.

All signals are balanced. Meaning there is always a pair (+/-) for each signal, like used in RS422. The X.21 signals are the same as RS422, so please refer to RS422 for the exact details.

Pinning according to ISO 4903

	
Sub-D15 Male	Sub-D15 Female

Pin	Signal	abbr.	DTE	DCE
1	Shield		-	-
2	Transmit (A)		Out	In
3	Control (A)		Out	In
4	Receive (A)		In	Out
5	Indication (A)		In	Out
6	Signal Timing (A)		In	Out
7	Unassigned			
8	Ground		-	-
9	Transmit (B)		Out	In
10	Control (B)		Out	In

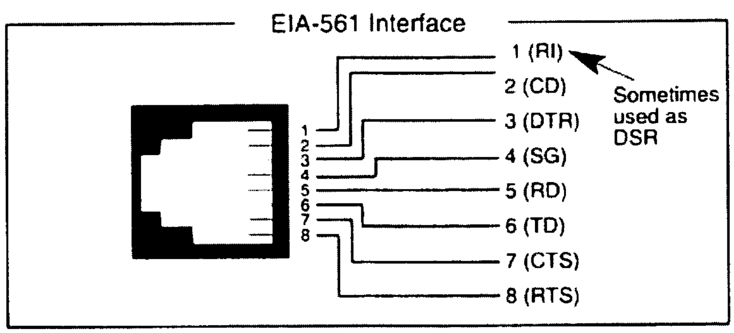
11	Receive (B)		In	Out
12	Indication (B)		In	Out
13	Signal Timing (B)		In	Out
14	Unassigned			
15	Unassigned			

Functional Description
As can be seen from the pinning specifications, the Signal Element Timing (clock) is provided by the DCE. This means that your provider (local telco office) is responsible for the correct clocking and that X.21 is a synchronous interface. Hardware handshaking is done by the Control and Indication lines. The Control is used by the DTE and the Indication is the DCE one.

Cross-cable pinning

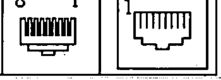
X.21 Cross Cable	
X.21	**X.21**
1	1
2	4
3	5
4	2
5	3
6	7
7	6
8	8
9	11
10	12
11	9
12	10
13	14
14	13
15	

EIA-561 defines RS-232 on a modular connector. (For nonsynchronous applications only, since it does not provide for the synchronous clocking signals.)



RS232D uses RJ45 type connectors (similar to telephone connectors)

	Male	Female
RJ45	8 1	1

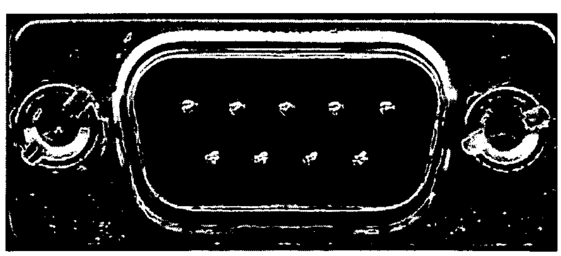


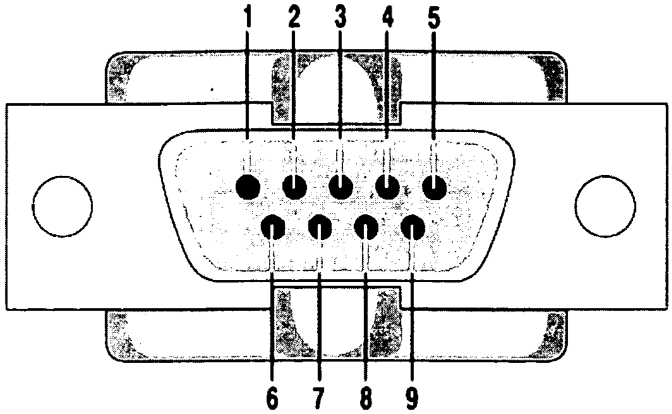
Pin No.	Signal Description	Abbr.	DTE	DCE
1	DCE Ready, Ring Indicator	DSR/RI	←	→
2	Received Line Signal Detector	DCD	←	→
3	DTE Ready	DTR	→	←
4	Signal Ground	SG		
5	Received Data	RxD	←	→
6	Transmitted Data	TxD	→	←
7	Clear To Send	CTS	←	→
8	Request To Send	RTS	→	←

This is a standard 9 to 25 pin cable layout for async data on a PC AT serial cable

Description	Signal	9-pin DTE	25-pin DCE	Source DTE or DCE
Carrier Detect	CD	1	8	from Modem
Receive Data	RD	2	3	from Modem
Transmit Data	TD	3	2	from Terminal/Computer
Data Terminal Ready	DTR	4	20	from Terminal/Computer
Signal Ground	SG	5	7	from Modem
Data Set Ready	DSR	6	6	from Modem
Request to Send	RTS	7	4	from Terminal/Computer
Clear to Send	CTS	8	5	from Modem
Ring Indicator	RI	9	22	from Modem

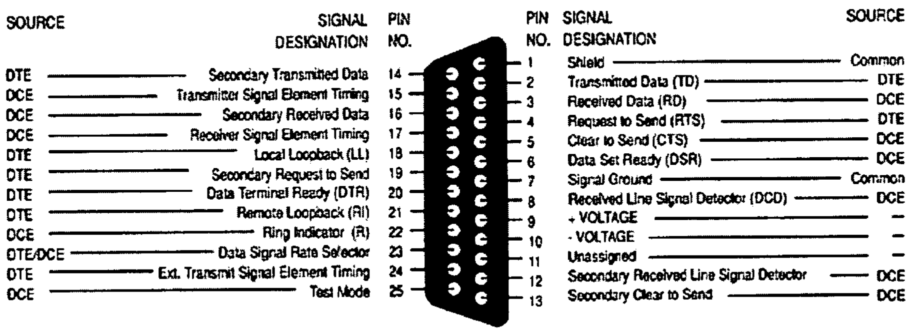
This a DTE port as on the back of a PC Com Port -
EIA-574 RS-232/V.24 pin out on a DB-9 pin
used for Asynchronous Data



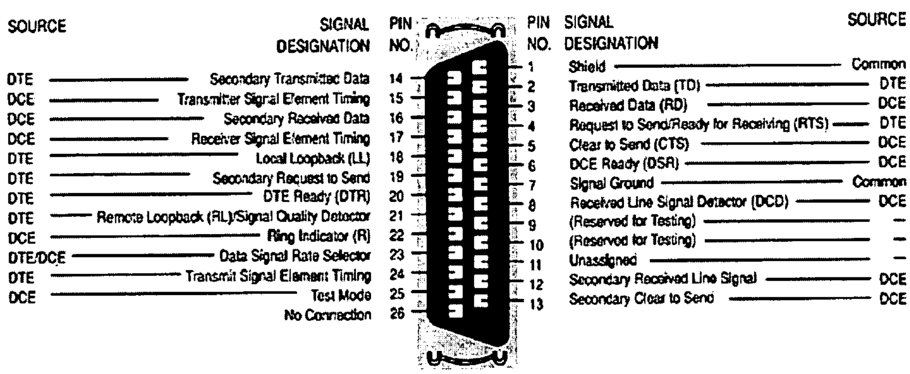


Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator
5	Signal Ground		

V.24/RS-232 Interface



V.24/RS-232E ALT A Connector



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25 pin D-shell connector RS232 commonly used for Async. data

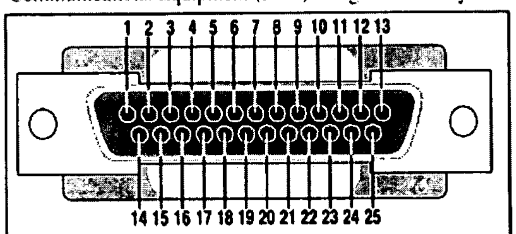
PIN SIGNAL DESCRIPTION

1 PGND Protective Ground
2 TXD Transmit Data
3 RXD Receive Data
4 RTS Ready To Send
5 CTS Clear To Send
6 DSR Data Set Ready
7 SG Signal Ground
8 CD Carrier Detect
20 DTR Data Terminal Ready
22 RI Ring Indicator

Some applications require more pins than a simple async. configurations.

RS-232 Interface

RS-232 (EIA Std.) applicable to the 25 pin interconnection of Data Terminal Equipment (DTE) and Data Communications Equipment (DCE) using serial binary data



Pin	Description	EIA CKT	From DCE	To DCE
1	Frame Ground	AA		
2	Transmitted Data	BA		D (Data)
3	Received Data	BB	D	
4	Request to Send	CA		C (Control)
5	Clear to Send	CB	C	
6	Data Set Ready	CC	C	
7	Signal Gnd/Common Return	AB		
8	Rcvd. Line Signal Detector	CF	C	
11	Undefined			
12	Secondary Rcvd. Line Sig. Detector	SCF	C	
13	Secondary Clear to Send	SCB	C	
14	Secondary Transmitted Data	SBA		D
15	Transmitter Sig. Element Timing	DB	T (Timing)	
16	Secondary Received Data	SBB	D	
17	Receiver Sig. Element Timing	DD	T	
18	Undefined			
19	Secondary Request to Send	SCA		C
20	Data Terminal Ready	CD		C
21	Sig. Quality Detector	CG		C
22	Ring Indicator	CE	C	
23	Data Sig. Rate Selector (DCE)	CI	C	
23	Data Sig. Rate Selector (DTE)	CH		C
24	Transmitter Sig. Element Timing	DA		T
25	Undefined			

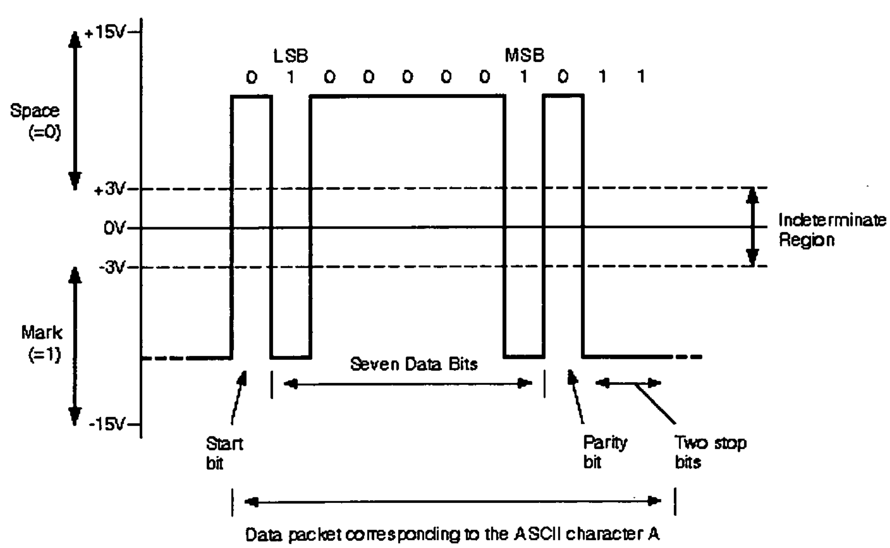
Pins used for Synchronous data

jump to Other Connector pages

RS-232 Specs.

SPECIFICATIONS		RS232	RS423
Mode of Operation		SINGLE -ENDED	SINGLE -ENDED
Total Number of Drivers and Receivers on One Line		1 DRIVER 1 RECVR	1 DRIVER 10 RECVR
Maximum Cable Length		50 FT.	4000 FT.
Maximum Data Rate		20kb/s	100kb/s
Maximum Driver Output Voltage		+/-25V	+/-6V
Driver Output Signal Level (Loaded Min.)	**Loaded**	+/-5V to +/-15V	+/-3.6V
Driver Output Signal Level (Unloaded Max)	**Unloaded**	+/-25V	+/-6V
Driver Load Impedance (Ohms)		3k to 7k	>=450
Max. Driver Current in High Z State	**Power On**	N/A	N/A
Max. Driver Current in High Z State	**Power Off**	+/-6mA @ +/-2v	+/-100uA
Slew Rate (Max.)		30V/uS	Adjustable
Receiver Input Voltage Range		+/-15V	+/-12V
Receiver Input Sensitivity		+/-3V	+/-200mV
Receiver Input Resistance (Ohms)		3k to 7k	4k min.

One byte of async data



Cabling considerations - you should use cabling made for RS-232 data but I have seen low speed data go over 250' on 2 pair phone cable. Level 5 cable can also be used but for best distance use a low capacitance data grade cable.

The standard maxim length is 50' but if data is async you can increase that distance to as much as 500' with a good grade of cable.

The RS-232 signal on a single cable is impossible to screen effectively for noise. By screening the entire cable we can

reduce the influence of outside noise, but internally generated noise remains a problem. As the baud rate and line length increase, the effect of capacitance between the different lines introduces serious crosstalk (this especially true on synchronous data - because of the clock lines) until a point is reached where the data itself is unreadable. Signal Crosstalk can be reduced by using low capacitance cable and shielding each pair

Using a high grade cable (individually shield low capacitance pairs) the distance can be extended to 4000'

At higher frequencies a new problem comes to light. The high frequency component of the data signal is lost as the cable gets longer resulting in a rounded, rather than square wave signal.

The maxim distance will depend on the speed and noise level around the cable run.

On longer runs a line driver is needed. This is a simple modem used to increase the maxim distance you can run RS-232 data.

Making sense of the specifications

Selecting data cable isn't difficult, but often gets lost in the shuffle of larger system issues. Care should be taken. however, because intermittent problems caused by marginal cable can be very difficult to troubleshoot.

Beyond the obvious traits such as number of conductors and wire gauge, cable specifications include a handful of less intuitive terms.

Characteristic Impedance (Ohms): A value based on the inherent conductance, resistance, capacitance and inductance of a cable that represents the impedance of an infinitely long cable. When the cable is out to any length and terminated with this Characteristic Impedance, measurements of the cable will be identical to values obtained from the infinite length cable. That is to say that the termination of the cable with this impedance gives the cable the appearance of being infinite length, allowing no reflections of the transmitted signal. If termination is required in a system, the termination impedance value should match the Characteristic Impedance of the cable.

Shunt Capacitance (pF/ft): The amount of equivalent capacitive load of the cable, typically listed in a per foot basis One of the factors limiting total cable length is the capacitive load. Systems with long lengths benefits from using low capacitance cable.

Propagation velocity (% of c): The speed at which an electrical signal travels in the cable. The value given typically must be multiplied by the speed of light (c) to obtain units of meters per second. For example, a cable that lists a propagation velocity of 78% gives a velocity of 0.78 X 300 X 106 - 234 X 106 meters per second.

Plenum cable

Plenum rated cable is fire resistant and less toxic when burning than non-plenum rated cable. Check building and fire codes for requirements. Plenum cable is generally more expensive due to the sheathing material used.

The specification recommends 24AWG twisted pair cable with a shunt capacitance of 16 pF per foot and 100 ohm characteristic impedance.

It can be difficult to qualify whether shielding is required in a particular system or not, until problems arise. We recommend erring on the safe side and using shielded cable. Shielded cable is only slightly more expensive than unshielded.

There are many cables available meeting the recommendations of RS-422 and RS-485, made specifically for that application. Another choice is the same cable commonly used in the Twisted pair Ethernet cabling. This cable, commonly referred to as Category 5 cable, is defined by the EIA/TIA/ANSI 568 specification The extremely high volume of Category 5 cable used makes it widely available and very inexpensive, often less than half the price of specialty RS422/485 cabling. The cable has a maximum capacitance of 17 pF/ft (14.5 pF typical) and characteristic impedance of 100 ohms.

Category 5 cable is available as shielded twisted pair (STP) as well as unshielded twisted pair (UTP) and generally exceeds the recommendations making it an excellent choice for RS232 systems.

RS232 - V.24/V.28 - IS2110 - X.20 bis (for Async) - X.21 bis (for Sync)

General

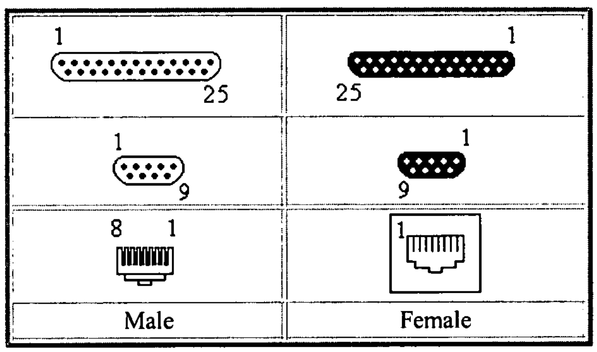
In this document the term RS232 will be used when refered to this serial interface. The description of RS232 is an EIA/TIA norm and is identical to CCITT V.24/V.28, X.20bis/X.21bis and ISO IS2110. The only difference is that CCITT has split the interface into its electrical description (V.28) and a mechanical part (V.24) or Asynchronous (X.20 bis) and Synchronous (X.21 bis) where the EIA/TIA describes everything under RS232.

As said before RS232 is a serial interface. It can be found in many different applications where the most common ones are modems and Personal Computers. All pinning specifications are writen for the DTE side.

All DTE-DCE cables are straight through meaning the pins are connected one on one. DTE-DTE and DCE-DCE cables are cross cables. To make a destiction between all different types of cables we have to use a naming convention.
DTE - DCE: Straight Cable
DTE - DTE: Null-Modem Cable
DCE - DCE: Tail Circuit Cable

Interface Mechanical

RS232 can be found on different connectors. There are special specifications for this. The CCITT only defines a Sub-D 25 pins version where the EIA/TIA has two versions RS232C and RS232D which are resp. on a Sub-D25 and a RJ45. Next to this IBM has added a Sub-D 9 version which is found an almost all Personal Computers and is described in TIA 457.



Pinnings

RS232-C	Description	Circuit EIA	Circuit CCITT	RJ45	TIA 457
1	Shield Ground	AA			
7	Signal Ground	AB	102	4	5
2	Transmitted Data	BA	103	6	3
3	Received Data	BB	104	5	2
4	Request To Send	CA	105	8	7
5	Clear To Send	CB	106	7	8
6	DCE Ready	CC	107	1	6
20	DTE Ready	CD	108.2	3	4
22	Ring Indicator	CE	125	1	9
8	Received Line Signal Detector	CF	109	2	1
23	Data Signal Rate Select (DTE/DCE Source>	CH/CI	111/112		
24	Transmit Signal Element Timing (DTE Source)	DA	113		
15	Transmitter Signal Element Timing (DCE Source)	DB	114		

17	Receiver Signal Element Timing (DCE Source)	DD	115		
18	Local Loopback / Quality Detector	LL	141		
21	Remote Loopback	RL/CG	140/110		
14	Secondary Transmitted Data	SBA	118		
16	Secondary Received Data	SBB	119		
19	Secondary Request To Send	SCA	120		
13	Secondary Clear To Send	SCB	121		
12	Secondary Received Line Signal Detector/ Data signal Rate Select (DCE Source)	SCF/CI	122/112		
25	Test Mode	TM	142		
9	Reserved for Testing				
10	Reserved for Testing				
11	Unassigned				

Interface Electrical

All signals are measured in reference to a common ground, which is called the signal ground (AB). A positive voltage between 3 and 15 Vdc represents a logical 0 and a negative voltage between 3 and 15 Vdc represents a logical 1.
This switching between positive and negative is called bipolar. The zero state is not defined in RS232 and is considered a fault condition (this happens when a device is turned off).
According to the above a maximum distance of 50 ft or 15 m. can be reached at a maximum speed of 20k bps. This is according to the official specifications, the distance can be exceeded with the use of Line Drivers.

Functional description

Description	Circuit	Function
Shield Ground	AA	Also known as protective ground. This is the chassis ground connection between DTE and DCE.
Signal Ground	AB	The reference ground between a DTE and a DCE. Has the value 0 Vdc.
Transmitted Data	BA	Data send by the DTE.
Received Data	BB	Data received by the DTE.
Request To Send	CA	Originated by the DTE to initiate transmission by the DCE.
Clear To Send	CB	Send by the DCE as a reply on the RTS after a delay in ms, which gives the DCEs enough time to energize their circuits and synchronize on basic modulation patterns.
DCE Ready	CC	Known as DSR. Originated by the DCE indicating that it is basically operating (power on, and in functional mode).
DTE Ready	CD	Known as DTR. Originated by the DTE to instruct the DCE to setup a connection. Actually it means that the DTE is up and running and ready to communicate.
Ring Indicator	CE	A signal from the DCE to the DTE that there is an incomming call (telephone is ringing). Only used on switched circuit connections.
Received Line Signal Detector	CF	Known as DCD. A signal send from DCE to its DTE to indicate that it has received a basic carrier signal from a (remote) DCE.
Data Signal Rate Select (DTE/DCE Source>	CH/CI	A control signal that can be used to change the transmission speed.
Transmit Signal Element Timing (DTE Source)	DA	Timing signals used by the DTE for transmission, where the clock is originated by the DTE and the DCE is the slave.
Transmitter Signal Element Timing (DCE Source)	DB	Timing signals used by the DTE for transmission.

Receiver Signal Element Timing (DCE Source)	DD	Timing signals used by the DTE when receiving data.
Local Loopback / Quality Detector	LL	
Remote Loopback	RL/CG	Originated by the DCE that changes state when the analog signal received from the (remote) DCE becomes marginal.
Test Mode	TM	
Reserved for Testing		

The secondary signals are used on some DCE's. Those units have the possibility to transmit and/or receive on a secondary channel. Those secondary channels are mostly of a lower speed than the normal ones and are mainly used for administrative functions.

Cable pinning

Here are some cable pinning that might be useful. Not all applications are covered, it is just a help:

Straight DB25 Cable

Pin	Pin
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25

DB25 Null- modem or cross over cable (Async)

Pin	Pin
1	1
2	3
3	2
4	5
5	4
6, 8	20
7	7
20	6, 8

</

DB9 Null- modem or cross over cable

1,6	4
2	3
3	2
4	1,6
5	5
7	8
8	7

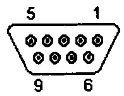
DB25 Tail- circuit or cross over cable cable (Sync)

Pin	Pin
1	1
2	3
3	2
4	8
6	20
7	7
8	4
17	24
20	6
24	17

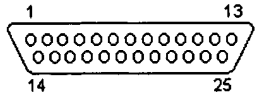
DB25 to DB9 DTE - DCE cable

Pin	Pin
	1
3	2
2	3
7	4
8	5
6	6
5	7
1	8
4	20
9	22

This cable should be used for DTE to DCE (for instance computer to modem) connections with hardware handshaking.



(To Computer).



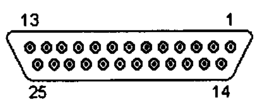
(To Modem).

9 PIN D-SUB FEMALE to the Computer
25 PIN D-SUB MALE to the Modem

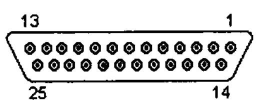
	Female	Male	Dir
Shield		1	
Transmit Data	3	2	
Receive Data	2	3	
Request to Send	7	4	
Clear to Send	8	5	
Data Set Ready	6	6	
System Ground	5	7	
Carrier Detect	1	8	
Data Terminal Ready	4	20	
Ring Indicator	9	22	

Nullmodem (25-25) Cable

Use this cable between two DTE devices (for instance two computers).



(To Computer 1).



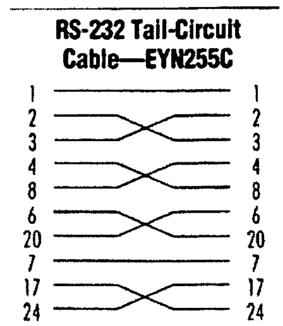
(To Computer 2).

25 PIN D-SUB FEMALE to Computer 1.
25 PIN D-SUB FEMALE to Computer 2.

	D-Sub 1	D-Sub 2	
Recieve Data	3	2	Transmit Data
Transmit Data	2	3	Receive Data
Data Terminal Ready	20	6+8	Data Set Ready + Carrier Detect
System Ground	7	7	System Ground
Data Set Ready + Carrier Detect	6+8	20	Data Terminal Ready
Request to Send	4	5	Clear to Send
Clear to Send	5	4	Request to Send

Note: DSR & CD are jumpered to fool the programs to think that their online.

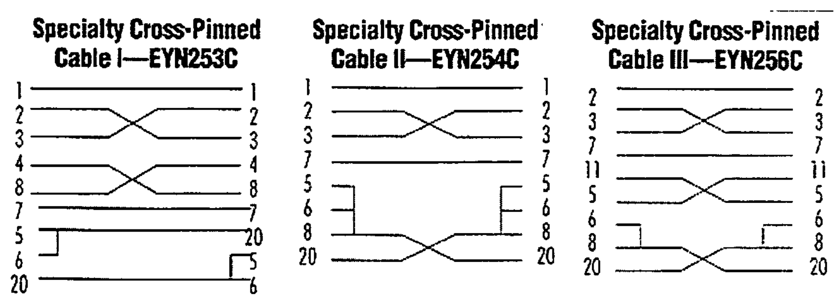
RS232 (25 pin) Tail Circuit Cable



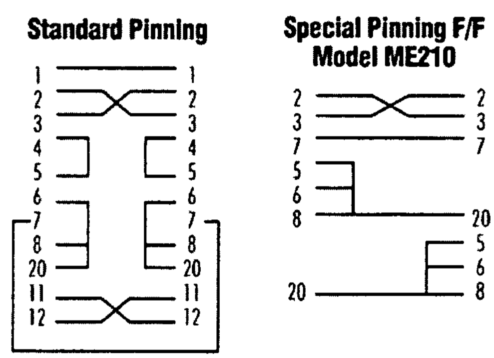
Null Modem cable diagrams

- Nullmodem (9p to 9p)
- Nullmodem (9p to 25p)
- Nullmodem (25p to 25p)

Cross Pinned cables for Async data.



Pin out for local Async Data transfer



Loopback plugs:

- Serial Port Loopback (9p)
- Serial Port Loopback (25p)

- jump to **related fiber cable pages**
- jump to The Belden Cable Company's cable selection tutorial pages
- jump to RS232 I/O

- jump to General Hardware Input/Output

(in-depth write ups)

- jump to RS232 by CAMI Research Inc
- jump to Interfacing the Serial / RS232 Port
- jump to Introduction to Serial Communications
- jump to Serial Communications
- jump to Serial Port Basics
- jump to http://electrosofts.com/serial
- jump to Parallel port

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jump to Data Modems for phone lines

jump to Data Modems for fiber optics

jump to Interface converters

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RS-422

a Tutorial

RS422 BALANCED DIFFERENTIAL DRIVERS

Line drivers and receivers are commonly used to exchange data between two or more points (nodes) on a network. Reliable data communications can be difficult in the presence of induced noise, ground level differences, impedance mismatches, failure to effectively bias for idle line conditions, and other hazards associated with installation of a network.

Standards have been developed to insure compatibility between units provided by different manufacturers, and to allow for reasonable success in transferring data over specified distances and/or data rates. The Electronics Industry Association (EIA) has produced standards for RS485, RS422, RS232, and RS423 that deal with data communications. Suggestions are often made to deal with practical problems that might be encountered in a typical network. EIA standards where previously marked with the prefix "RS" to indicate recommended standard; however, the standards are now generally indicated as "EIA" standards to identify the standards organization. While the standards bring uniformity to data communications, many areas are not specifically covered and remain as "gray areas" for the used to discover (usually during installation) on his own

The balanced voltage digital interface circuit will normally be utilized on data, timing, or control circuits where the data signaling rate is up to 10 Mbit/s. Balanced voltage digital interface devices meeting the electrical characteristics of need not operate over the entire data signaling rate range specified. They may be designed to operate over narrower ranges to satisfy more economically specific applications, particularly at the lower modulation rates.

When communicating at high data rates, or over long distances in real world environments, single-ended methods are often inadequate. Differential data transmission (balanced differential signal) offers superior performance in most applications. Differential signals can help nullify the effects of ground shifts and induced noise signals that can appear as common mode voltages on a network.

RS422 (differential) was designed for greater distances and higher Baud rates than RS232. In its simplest form, a pair of converters from RS232 to RS422 (and back again) can be used to form an "RS232 extension cord." Data rates of up to 100K bits / second and distances up to 4000 Ft. can be accommodated with RS422. RS422 is also specified for multi-drop (party-line) applications where only one driver is connected to, and transmits on, a "bus" of up to 10 receivers.

While a multi-drop "type" application has many desirable advantages, RS422 devices cannot be used to construct a truly multi-point network. A true multi-point network consists of multiple drivers and receivers connected on a single bus, where any node can transmit or receive data.

"Quasi" multi-drop networks (4-wire) are often constructed using RS422 devices. These networks are often used in a half-duplex mode, where a single master in a system sends a command to one of several "slave" devices on a network. Typically one device (node) is addressed by the host computer and a response is received from that device. Systems of this type (4-wire, half-duplex) are

often constructed to avoid "data collision" (bus contention) problems on a multi-drop network (more about solving this problem on a two-wire network in a moment).

Compatibility With Other Interfaces

Both RS-422 and RS-485 use a twisted-pair wire (i.e. 2 wires) for each signal. They both use the same differential drive with identical voltage swings: 0 to +5V. The main difference between RS-422 and RS-485 is that while RS-422 is strictly for point-to-point communications (and the driver is always enabled), RS-485 can be used for multidrop systems (and the driver has a tri-state capability).

As stated in the scope of this Standard, generators and receivers meeting the requirements of RS-422-A are compatible with those meeting CCITT Recommendations V. 11 and X.27. The electrical characteristics of the balanced voltage digital interface are designed to allow use of both balanced and unbalanced (see EIA Standard RS-423-A) circuits within the same interconnection cable sheath. For example, the balanced circuits may be used for data and timing while the unbalanced circuits may be used for low speed control functions.

Since the basic differential receivers of RS-423-A and RS422-A are electrically identical, it is possible to interconnect an equipment using RS423-A receivers and generators on one side of the interface with an equipment using RS422-A generators and receivers on the other side of the interface, if the leads of the receivers and generators are properly configured to accommodate such an arrangement and the cable is not terminated.

The balanced interface circuit is not intended for interoperation with other interface electrical characteristics such as RS-232-C. MIL-STD-188C and MIL-STD-188-100, and CCITT Recommendations V.28 and V.35. Under certain conditions. interoperation with circuits of some of the above interfaces may be possible but may require modification in the interface or within the equipment; therefore, satisfactory operation is not assured. and additional provisions not specified herein may be required.

SPECIFICATIONS		RS423	RS422
Mode of Operation		SINGLE - ENDED	DIFFERENTIAL
Total Number of Drivers and Receivers on One Line		1 DRIVER 10 RECVR	1 DRIVER 10 RECVR
Maximum Cable Length		4000 FT.	4000 FT.
Maximum Data Rate		100kb/s	10Mb/s
Maximum Driver Output Voltage		+/-6V	-0.25V to +6V
Driver Output Signal Level (Loaded Min.)	**Loaded**	+/-3.6V	+/-2.0V
Driver Output Signal Level (Unloaded Max)	**Unloaded**	+/-6V	+/-6V
Driver Load Impedance (Ohms)		>450	100
Max. Driver Current in High Z State	**Power On**	N/A	N/A
Max. Driver Current in High Z State	**Power Off**	+/-100uA	+/-100uA
Slew Rate (Max.)		Adjustable	N/A
Receiver Input Voltage Range		+/-12V	-10V to +10V
Receiver Input Sensitivity		+/-200mV	+/-200mV

Receiver Input Resistance (Ohms)	4k min.	4k min.

Making sense of cable specifications

Selecting data cable for an RS-422 or RS-485 system isn't difficult, but often gets lost in the shuffle of larger system issues. Care should be taken. however, because intermittent problems caused by marginal cable can be very difficult to troubleshoot.

Beyond the obvious traits such as number of conductors and wire gauge, cable specifications include a handful of less intuitive terms.

Characteristic Impedance (Ohms): A value based on the inherent conductance, resistance, capacitance and inductance of a cable that represents the impedance of an infinitely long cable. When the cable is out to any length and terminated with this Characteristic Impedance, measurements of the cable will be identical to values obtained from the infinite length cable. That is to say that the termination of the cable with this impedance gives the cable the appearance of being infinite length, allowing no reflections of the transmitted signal. If termination is required in a system, the termination impedance value should match the Characteristic Impedance of the cable.

Shunt Capacitance (pF/ft): The amount of equivalent capacitive load of the cable, typically listed in a per foot basis One of the factors limiting total cable length is the capacitive load. Systems with long lengths benefits from using low capacitance cable.

Propagation velocity (% of c): The speed at which an electrical signal travels in the cable. The value given typically must be multiplied by the speed of light (c) to obtain units of meters per second. For example, a cable that lists a propagation velocity of 78% gives a velocity of 0.78 X 300 X 106 - 234 X 106 meters per second.

Plenum cable

Plenum rated cable is fire resistant and less toxic when burning than non-plenum rated cable. Check building and fire codes for requirements. Plenum cable is generally more expensive due to the sheathing material used.

The RS-422 specification recommends 24AWG twisted pair cable with a shunt capacitance of 16 pF per foot and 100 ohm characteristic impedance. While the RS-485 specification does not specify cabling, these recommendations should be used for RS485 systems as well.

It can be difficult to quantity whether shielding is required in a particular system or not, until problems arise. We recommend erring on the safe side and using shielded cable. Shielded cable is only slightly more expensive than unshielded.

There are many cables available meeting the recommendations of RS-422 and RS-485, made specifically for that application. Another choice is the same cable commonly used in the misted pair Ethernet cabling. This cable, commonly referred to as Category 5 cable, is defined by the EIA/TIA/ANSI 568 specification The extremely high volume of Category 5 cable used makes it widely available and very inexpensive, often less than half the price of specialty RS422/485 cabling. The cable has a maximum capacitance of 17 pF/ft (14.5 pF typical) and characteristic impedance of 100 ohms.

Category 5 cable is available as shielded twisted pair (STP) as well as unshielded twisted pair (UTP) and generally exceeds the recommendations for RS-422 making it an excellent choice for

RS-422 and RS-485 systems.

RS232 & Cable Diagrams info (how it works and spec. & pin outs)
X.21 info (how it works and spec. & pin outs)
RS423 info (spec. & pin outs)
RS485 info (how it works and spec. & pin outs)
RS449 info (how it works and spec. & pin outs)
RS530 info spec.
V.35 info (how it works and spec.& pin outs)
IEEE-488 info (pin layout)
USCO Codes
RJ-48C and RJ48S jack pin out
RJ 11C thru RJ48 Jacks - a Glossary

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jump to **Interface Converters** pages jump to **more technical information pages**

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RS485 Data Interface

a Tutorial

RS485 Data Acquisition Communications.

National Semiconductor RS485 page.
Good general information concerning RS485 and other serial communications topics.

Global Engineering
A good source for technical and standards documentation.

RS-485
BALANCED DIFFERENTIAL DRIVERS
Balanced Line Drivers

RS485 -

is a specialized interface that would not be considered standard equipment on today's home PC but is very common in the data acquisition world. RS232 is the most common interface used to communicate serially but it has it's limitations.

Standards have been developed to insure compatibility between units provided by different manufacturers, and to allow for reasonable success in transferring data over specified distances and/or data rates. The Electronics Industry Association (EIA) has produced standards for RS485, RS422, RS232, and RS423 that deal with data communications. Suggestions are often made to deal with practical problems that might be encountered in a typical network. EIA standards where previously marked with the prefix "RS" to indicate recommended standard; however, the standards are now generally indicated as "EIA" standards to identify the standards organization. While the standards bring uniformity to data communications, many areas are not specifically covered and remain as "gray areas" for the used to discover (usually during installation) on his own

RS485 will support 32 drivers and 32 receivers (we are talking about bi-directional - half duplex - multi-drop communications over a single or dual twisted pair cable !!).

An RS-485 network can be connected in a 2 or 4 wire mode. Maximum cable length can be as much as 4000 feet because of the differential voltage transmission system used. The typical use for RS485 is a single PC connected to several addressable devices that share the same cable. You can think of RS485 as a "party-lined" communications system (the addressing is handled by the Remote Computer unit). The RS232 may be converted to RS485 with a simple interface converter - it can have optical isolation and surge suppression. Electronic data communications between elements will generally fall into two broad categories: single-ended and differential. RS232 (single-ended) was introduced in 1962, and despite rumors for its early demise, has remained widely used through the industry. The specification allows for data transmission from one transmitter to one receiver at relatively slow data rates (up to 20K bits/second) and short distances (up to 50Ft. @ the maximum data rate).

Independent channels are established for two-way (full-duplex) communications. The RS232 signals are represented by voltage levels with respect to a system common (power / logic ground). The "idle" state (MARK) has the signal level negative with respect to common, and the "active" state (SPACE) has the signal level positive with respect to common. RS232 has numerous handshaking lines (primarily used with modems), and also specifies a communications protocol. In general if you are not connected to a modem the handshaking lines can present a lot of problems if not disabled in software or accounted for in the hardware (loop-back or pulled-up). RTS (Request to send) does have some utility in certain applications. RS423 is another single ended specification with enhanced operation over RS232; however, it has not been widely used in the industry.

RS232 signals are represented by voltage levels with respect to system common (power ground). This type of signal works well in point to point communications at low data transmission rates. RS232 ports on the PC are assigned to a single device. COM1 could be the mouse port and COM2 used for a modem. This is a example of point to point (one port communicates with one device). RS232 signals require a common ground between the PC and the associated device. Wiring distances should be limited to one or two hundred feet on async. data and about 50 feet with sync. data (that may be pushing things in some cases). Synchronous data has a transmit and receive clock that limits the max distance you can go on a sync. data line

In short, the RS232 port was designed to communicate with local devices, and will support one driver and one receiver.

When communicating at high data rates, or over long distances in real world environments, single-ended methods are often inadequate. Differential data transmission (balanced differential signal) offers superior performance in most applications. Differential signals can help nullify the effects of ground shifts and

induced noise signals that can appear as common mode voltages on a network.

RS422 (differential) was designed for greater distances and higher Baud rates than RS232. In its simplest form, a pair of converters from RS232 to RS422 (and back again) can be used to form an "RS232 extension cord." Data rates of up to 100K bits / second and distances up to 4000 Ft. can be accommodated with RS422. RS422 is also specified for multi-drop (party-line) applications where only one driver is connected to, and transmits on, a "bus" of up to 10 receivers.

While a multi-drop "type" application has many desirable advantages, RS422 devices cannot be used to construct a truly multi-point network. A true multi-point network consists of multiple drivers and receivers connected on a single bus, where any node can transmit or receive data.

"Quasi" multi-drop networks (4-wire) are often constructed using RS422 devices. These networks are often used in a half-duplex mode, where a single master in a system sends a command to one of several "slave" devices on a network. Typically one device (node) is addressed by the host computer and a response is received from that device. Systems of this type (4-wire, half-duplex) are often constructed to avoid "data collision" (bus contention) problems on a multi-drop network (more about solving this problem on a two-wire network in a moment).

RS485 meets the requirements for a truly multi-point communications network, and the standard specifies up to 32 drivers and 32 receivers on a single (2-wire) bus. With the introduction of "automatic" repeaters and high-impedance drivers / receivers this "limitation" can be extended to hundreds (or even thousands) of nodes on a network. RS485 extends the common mode range for both drivers and receivers in the "tri-state" mode and with power off. Also, RS485 drivers are able to withstand "data collisions" (bus contention) problems and bus fault conditions.

To solve the "data collision" problem often present in multi-drop networks hardware units (converters, repeaters, micro-processor controls) can be constructed to remain in a receive mode until they are ready to transmit data. Single master systems (many other communications schemes are available) offer a straight forward and simple means of avoiding "data collisions" in a typical 2-wire, half-duplex, multi-drop system. The master initiates a communications request to a "slave node" by addressing that unit. The hardware detects the start-bit of the transmission and automatically enables (on the fly) the RS485 transmitter. Once a character is sent the hardware reverts back into a receive mode in about 1-2 microseconds (at least with R.E. Smith converters, repeaters, and remote I/O boards).

Any number of characters can be sent, and the transmitter will automatically re-trigger with each new character (or in many cases a "bit-oriented" timing scheme is used in conjunction with network biasing for fully automatic operation, including any Baud rate and/or any communications specification, eg. 9600,N,8,1). Once a "slave" unit is addressed it is able to respond immediately because of the fast transmitter turn-off time of the automatic device. It is NOT necessary to introduce long delays in a network to avoid "data collisions." Because delays are NOT required, networks can be constructed, that will utilize the data communications bandwidth with up to 100% through put.

SPECIFICATIONS		RS485
Mode of Operation		DIFFERENTIAL
Total Number of Drivers and Receivers on One Line		1 DRIVER 32 RECEIVER
Maximum Cable Length		4000 FT.
Maximum Data Rate		10Mb/s
Maximum Driver Output Voltage		-7V to +12V
Driver Output Signal Level (Loaded Min.)	**Loaded**	+/-1.5V
Driver Output Signal Level (Unloaded Max)	**Unloaded**	+/-6V
Driver Load Impedance (Ohms)		54
Max. Driver Current in High Z State	**Power On**	+/-100uA
Max. Driver Current in High Z State	**Power Off**	+/-100uA
Slew Rate (Max.)		N/A
Receiver Input Voltage Range		-7V to +12V
Receiver Input Sensitivity		+/-200mV
Receiver Input Resistance (Ohms)		>=12k

SELECTION OF TRANSMISSION LINE FOR RS-485

When choosing a transmission line for RS-485, it is necessary to examine the required distance of the cable and the data rate of the system. Losses in a transmission line are a combination of ac losses (skin effect), dc conductor loss, leakage, and ac losses in the dielectric. In high quality cable, the conductor losses and the dielectric losses are on the same order of magnitude.

CABLE SELECTION FOR RS-422 AND RS-485 SYSTEMS

Selecting data cable for an RS-422 or RS-485 system isn't difficult, but often gets lost in the shuffle of larger system issues. Care should be taken, however, because

intermittent problems caused by marginal cable can be very difficult to troubleshoot.

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The RS-422 specification recommends 24AWG twisted pair cable with a shunt capacitance of 16 pF per foot and 100 ohm characteristic impedance. While the RS-485 specification does not specify cabling, these recommendations should be used for RS-485 systems as well.

It can be difficult to quantify whether shielding is required in a particular system or not, until problems arise. We recommend erring on the safe side and using shielded cable. Shielded cable is only slightly more expensive than unshielded.

There are many cables available meeting the recommendations of RS-422 and RS-485, made specifically for that application. Another choice is the same cable commonly used in the twisted pair Ethernet cabling. This cable, commonly referred to as Category 5 cable, is defined by the EIA/TIA/ANSI 568 specification. The extremely high

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